Economic Modelling 33 (2013) 787–793

Contents lists available at SciVerse ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

# Panel threshold analysis of Taiwan's outbound visitors ☆

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ARTICLE INFO

*Article history:*
Accepted 6 June 2013

*Keywords:*
Number of people traveling abroad
Consumer price index (CPI)
Threshold effect

ABSTRACT

The main purpose of this research is to explore the panel threshold effect of consumer prices in destination countries on the number of Taiwanese outbound visitors. It is assumed that a destination country's inflated prices contain one or more threshold values and have nonlinear relation with the number of Taiwanese people visiting that particular country, with asymmetric upper and lower boundaries. Scrutinizing 14 countries during a 14-year period (from 1998 to 2011), this study examines the panel threshold effects based on balanced panel data that comprises 196 observations. The empirical findings suggest the absence of any significant panel threshold effect, regardless of the assumed double or single threshold effect. According to an ensuing inter-segment symmetry analysis, impact factors within the range of study invariably indicated significantly positive relations, a sign that a destination country's consumer price index (CPI) has a positive linear relation with the number of Taiwanese people traveling abroad. In other words, the rising prices in destination countries do not reduce Taiwanese people's demand for traveling abroad. Instead, it reflects the improving economy as well as surging quality of life in a destination country that encourages refinement of products, perfects traveling facilities, and consequently lures quality-seeking tourists as well as Taiwanese outbound visitors. The finding gives a clear guidance that Taiwan's tourism policy shall add sophistication to services in every aspect.


## 1. Introduction

In an all-out effort toward a 100% growth in tourist numbers, Taiwan's Executive Yuan vowed to achieve 5 million tourist arrivals by 2010 with *tourism promotion* listed among the five major planks of government policies, as instructed by President Ma Ying-jeou. According to the Annual Report on Tourism published by Tourism Bureau, there has been a tremendous gap between Taiwan's inbound and outbound tourists. For example, the number of inbound tourists increased from 1,409,465 in 1981 to 2,617,137 in 2001, which is approximately a 100% growth. On the other hand, the number of outbound visitors jumped nearly 12.5 times from 575,537 in 1981 to 7,189,334 in 2001.

Tourism service providers as well as academics attribute Taiwan's long-time failure to effectively attract travelers worldwide, despite its many dazzling scenic attractions, to the exorbitant consumer prices. That is, the excessively high costs of airfare, hotel accommodations, dining and transportation have scared away both foreign and domestic tourists. However, the neighboring countries/regions (i.e., Hong Kong, Japan and Singapore) register annual tourist arrivals many times higher than Taiwan with consumer prices exceeding the Taiwanese level. Among others, Singapore and Hong Kong are known for their tiny areas but still achieved impressive results in terms of tourism. The above-mentioned facts prompted this study of how consumer price index (CPI) affects, and interacts with, tourist arrival statistics. Findings from this study are expected to benefit Taiwanese authorities concerning tourism policy-making and relevant investment measures, to clarify public beliefs, and also to provide a set of correct indicators in this regard.

CPI is generally considered a crucial factor that affects the demand for consumption. According to the law of demand, consumer prices are in inverse proportion to the demand for common goods, which means a higher CPI will reduce the demand for commodities. That law is supposed to have the same explanatory power when it comes to the demand for tourism services. For instance, the number of Taiwanese people traveling overseas is believed to be significantly affected by destination countries' prices in inverse proportion.

Previous studies of the interaction between consumer prices and tourism include the one conducted by Lee et al. (1996) about how CPI affects the occupancy rate of local hotels[1]; an analysis by Oppermann and Cooper (1999) regarding the impact of airfare costs in New Zealand on the airlines; a research co-authored by Lindberg and Aylward (1999) on the price elasticity and the number of visitors in the top three Costa Rican national parks. While Papatheodorou (1999), and Goodrich (2001) discussed the relation between consumer prices and tourism, Toh et al. (2001) factored income and consumer prices into a


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[1] According to the study, a CPI increase of 1% per day will lead to a 1.8% decrease in the occupancy rate at local hotels.

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http://dx.doi.org/10.1016/j.econmod.2013.06.006

similar study; Webber (2001) examined prices and exchange-rate fluctuations into his research; Qiu and Zhang (1995) included three macro-economic variables (i.e., income, consumer prices, and exchange rate) in their tourism-themed research. The researchers all mentioned above noted a significant influence of the tourist price index on tourist consumption.

Taiwanese people traveling abroad have been rising in number over the past few years.[2] While there are many economic causes of the increase in outbound visitors and opinions vary among scholars, consumer prices undoubtedly exert an influence on such an increase. In their study of how prices affect the number of Taiwanese people traveling abroad, Qian and Li (1998) considered CPI the leading indicator of outbound visitor statistics, among the other macro-economic factors. By means of variance decomposition, they went on to say that CPI is able to explain 99% of the outbound visitor tally. Likewise, Kashyap and Bojanic (2000) found CPI to be a major factor behind the number of outbound travelers.

Under the assumption of *law of demand*, surging consumer prices in a destination country will cause the tourist arrival figure to drop due to relatively high prices. In other words, there is a negative relation between prices in a destination country and the tourist arrival figure. Nevertheless, the surging prices in a destination country signify improved economy and a better quality of life that further encourages product refinement. Consequently, a high-quality travel destination where prices are high has the potential of luring more tourists who seek high-quality services. That is, surging prices may result in an increased tourist arrival figure, hence the positive relation between prices in a destination country and the tourist arrival figure. If that reasonable hypothesis is substantiated, when prices in a specific destination country are below or above a certain degree, the relation between tourist arrival figure and prices in a destination country will change from a negative one to a positive, vertically asymmetric, nonlinear relation. That suggests a threshold effect between the number of people traveling abroad and prices in a destination country. Therefore, this study examines how the *threshold effect* of prices in a destination country affects the number of Taiwanese people traveling abroad. Unlike a typical research of a specific destination country, this study uses panel data to analyze the panel threshold effect regarding 14 countries that are in relatively frequent contact with Taiwanese travel agencies, hoping to offer a comprehensive discussion of how Taiwanese providers of overseas travel services are affected by prices in the destination country.

## 2. Sources of data

This present study explores how the extent of consumer-price growth in a destination country affects the number of outbound visitors in that particular country, based on the assumption that the CPI in a destination country not only has one or more threshold values, but also related to the number of outbound visitors in that particular country in a nonlinear manner, with asymmetric upper and lower boundaries. Considering the plural destination countries for Taiwanese travelers, this present study is based on the 2011 data of outbound tourists and focuses on destination countries with 50,000 or more visitors from Taiwanese annually (i.e., Hong Kong, Japan, South Korea, Singapore, Malaysia, Thailand, the Philippines, Indonesia, Vietnam, Macau, the U.S., Canada, the Netherlands and New Zealand). Because complete data about Taiwan's outbound visitors in Vietnam, Macau and New Zealand was unavailable until 1999, the three regions are excluded from this study, which examines 11 countries/regions in total. Since Europe is an increasingly popular destination and growing market among Taiwanese tourists in recent years, the U.K., France and Germany are included in this study. As a result, 14 countries were sampled as tourist destinations during a 14-year period between 1998 and 2011 to generate balanced panel data.[3] While CPI was used to represent the consumer prices in destination countries, data for this study was obtained from the AREMOS system established by the Ministry of Education under Taiwan Academic Network (TANet); the annual numbers of outbound visitors were obtained from the Annual Report on Tourism published by Ministry of Transportation and Communications Tourism Bureau. To better understand the properties of each variable, information was compiled in the form of basic descriptive statistics such as the cross-sectional basic statistics concerning the CPI in 14 destination countries, which are the threshold variables, and the number of Taiwan's outbound visitors (see Table 1). Table 2 also shows the time-series basic statistics of two variables over a 14-year period of time.

### 3. Methodology

This study conducted empirical testing using methodology patterned after the panel threshold method proposed by Hansen (1999). First presented by Tong (1978), the threshold model was an application of the threshold autoregression (TAR) model to the empirical testing of nonlinear time series. Applicable to a wide range of financial and economic issues, the TAR model uses threshold variables to determine segmentation points in a relatively objective way, so as to avoid negative consequences of the usually arbitrary determination (of segmentation points). That is, the TAR model estimates appropriate threshold values based on observations of the threshold variables.

Before generating estimates, the TAR model's threshold effect must first be tested using a null hypothesis (H0) that the threshold effect is absent in the model. When H0 is substantiated, the unidentifiable threshold values along with the presence of nuisance parameter will result in a non-standard distribution of conventional test statistics. [4]Consequently, Hansen (1996) proposed the bootstrap method to yield test statistics in an asymptotic distribution, in order to test the model's threshold effect.

Meanwhile, Chan (1993) and Hansen (2000) proved that the presence of a fixed threshold effect is linked to super-consistency in the least squares estimators of thresholds. Chan (1993) therefore inferred from that finding an asymptotic distribution, which however is affected by the nuisance parameter and would lead to a highly non-standard distribution, hence the unsuitability for statistical inferences. To solve that problem, Hansen (1999, 2000) in a simulation of "likelihood ratio test" obtained the asymptotic distribution of statistics to test the model's threshold effect.

To avoid difficulty in nonlinear estimation, Hansen (1999) proposed a comprehensive set of assumptions for a threshold panel-data model, along with the estimation and testing methods. He suggested the approach of a two-stage linear ordinal least squares (OLS), with each threshold value ($\gamma$) determined and the sum of squared errors (SSR) obtained through OLS in the first stage. In the second stage, threshold values ($\hat{\gamma}$) are calculated using the minimum SSP. After obtaining the estimated threshold values, the regression coefficient in each threshold-defined segment was calculated for a result analysis.

[2] The number of Taiwanese people traveling overseas has drastically increased since the Taiwan government switched to an open-up policy toward tourism in 1979. The Tourism Bureau data shows a growth of 11.7 times in Taiwan's outbound visitors from 1980 to 2001. The number of R.O.C. citizens traveling abroad has reached 7,189,334 by 2001, which amounts to a third of the Taiwanese population.

[3] This study collected balanced panel data from 14 countries over a period of 14 years, which generated 196 ($=14 \times 14$) observations for the destination countries' CPI and number of outbound travelers.

[4] The fact that nuisance parameters lead to a non-standard distribution is commonly known as the "Davies" problem (Davis, 1977, 1987). Andrews and Ploberger (1994) and Hansen (1996) had conducted testing concerning this problem.

**Table 1**
Cross-sectional basic statistics of destination countries' CPI and the number of Taiwanese people visiting each destination country.

| | NOT | | | | | CPI | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average | Standard deviation | Maximum | Minimum | J–B | Average | Standard deviation | Maximum | Minimum | J–B |
| Hong Kong | 1,840,353 | 463,425 | 2,582,837 | 810,977 | 0.8585 | 87.7 | 16.68 | 106.9 | 55.6 | 1.5670 |
| Japan | 669,630 | 101,319 | 811,388 | 474,245 | 0.8788 | 97.8 | 2.98 | 101.3 | 90.1 | 5.4741* |
| South Korea | 143,215 | 72,160 | 302,184 | 87,043 | 4.6418* | 84.9 | 16.27 | 108.3 | 57.2 | 0.9298 |
| Singapore | 224,906 | 78,503 | 336,954 | 70,924 | 0.8318 | 95.8 | 6.01 | 102.1 | 83.7 | 1.5596 |
| Malaysia | 185,120 | 77,703 | 299,664 | 57,074 | 1.0004 | 88.1 | 11.68 | 103.8 | 69.4 | 1.0539 |
| Thailand | 409,487 | 86,403 | 557,184 | 258,668 | 0.5833 | 86.4 | 14.94 | 104.7 | 63.1 | 1.3959 |
| The Philippines | 133,143 | 55,488 | 200,097 | 38,933 | 1.3431 | 117.2 | 35.34 | 168.6 | 61.8 | 0.9628 |
| Indonesia | 152,365 | 70,729 | 254,180 | 23,301 | 0.9404 | 133.6 | 74.72 | 260.0 | 57.4 | 1.8653 |
| The U.S. | 452,857 | 157,596 | 651,134 | 157,565 | 1.5269 | 155.2 | 16.81 | 180.9 | 126.1 | 0.6836 |
| Canada | 84,692 | 61,112 | 181,409 | 1283 | 0.9874 | 105.8 | 8.27 | 120.4 | 90.6 | 0.2285 |
| France | 16,223 | 11,916 | 28,824 | 195 | 2.015 | 96.7 | 6.51 | 106.7 | 85.0 | 0.7032 |
| Germany | 15,185 | 16,021 | 46,387 | 187 | 1.6896 | 93.4 | 8.01 | 104.0 | 79.0 | 1.0640 |
| The Netherlands | 56,763 | 49,005 | 137,201 | 13,897 | 2.1279 | 92.1 | 9.19 | 108.1 | 77.9 | 0.5823 |
| The U.K. | 22,639 | 17,439 | 42,202 | 404 | 1.8737 | 155.2 | 16.81 | 180.9 | 126.1 | 0.6836 |

Note: 1. NOT and CPI denote the number of Taiwanese visitors and CPI in the destination countries, respectively.
2. The totally 14 destination countries were studied over a 14-year period from 1998 to 2011.
3. J–B denotes the basic Jarque–Bera statistics in a standard normal distribution.
4. *Indicates significance at a 10% significance level.

The panel threshold model proposed by Hansen (1999), along with the estimation and testing methods, is described as follows:

A. Model

In an attempt to explore how a destination country's prices affect the number of Taiwanese people visiting that particular country, this study collected balanced panel data concerning the number of Taiwanese visitors in 14 sampled countries during the 14-year period between 1998 and 2011. Given the presumed thresholds in a nonlinear relation, the extent of consumer-price inflation in a destination country may have different influences on the growth in Taiwanese visitors in that country above and below those thresholds. We built a threshold model as follows, patterned after the one presented by Hansen (1999):

$$n_{it} = \begin{cases} \mu_i + \beta_1^{'}\pi_{it} + \varepsilon_{it} & \text{if } \pi_{it} \le \gamma \\ \mu_i + \beta_2^{'}\pi_{it} + \varepsilon_{it} & \text{if } \pi_{it} > \gamma \end{cases} \tag{1}$$

where $n_{it}$ denotes the growth of Taiwanese visiting a destination country; $\pi_{it}$ is the inflation in destination country, with the threshold variable being the inflation $\pi$ in research model; $\gamma$ is the assumed specific threshold value; $\mu_i$ denotes the fixed effect that captures the socioeconomic heterogeneity of different countries; the error item $\varepsilon_{it}$ displays an expected value of 0, with the variance being the identically independent distribution of $\sigma^2$ (i.e., $\varepsilon_{it} \sim iid(0,\sigma^2)$). In the model, the underlined I denotes a specific country and t a specific time period.

Regression Eq. (1) in the threshold model can be re-written as regression Eqs. (2) and (3), as shown below:

$$n_{it} = \mu_i + \beta_1^{'}\pi_{it}I(\pi_{it} \le \gamma) + \beta_2^{'}\pi_{it}I(\pi_{it} > \gamma) + \varepsilon_{it} \tag{2}$$

where I (.) is an indicator function:

$$n_{it} = \mu_i + \beta^{'}\pi_{it}(\gamma) + \varepsilon_{it} \tag{3}$$

where $\beta = (\beta_1^{'}, \beta_2^{'})$ and

$$\pi_{it} = \begin{bmatrix} \pi_{it}I(\pi_{it} \le \gamma) \\ \pi_{it}I(\pi_{it} > \gamma) \end{bmatrix}.$$

The purpose of this present study is to estimate unknown parameters $\gamma$, $\beta$ and $\sigma^2$ using information collected during a known time period and parameters $n_{it}$ and $\pi_{it}$ of sampled countries.

**Table 2**
Time-series basic statistics of destination countries' CPI and the number of Taiwanese people visiting each destination country.

| | NOT | | | | | CPI | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average | Standard deviation | Maximum | Minimum | J–B | Average | Standard deviation | Maximum | Minimum | J–B |
| 1998 | 149,019 | 231,586 | 810,977 | 226 | 14.0839*** | 80.2 | 22.97 | 126.1 | 55.6 | 2.0967 |
| 1999 | 208,782 | 344,483 | 1,245,764 | 187 | 20.4295*** | 84.99 | 23.48 | 133.8 | 61.9 | 3.2590 |
| 2000 | 238,290 | 374,012 | 1,368,295 | 286 | 21.0655*** | 89.2 | 22.96 | 137.9 | 68.0 | 4.0578 |
| 2001 | 293,582 | 464,918 | 1,747,404 | 334 | 28.5300*** | 92.4 | 22.93 | 141.9 | 71.4 | 4.8468* |
| 2002 | 319,418 | 509,857 | 1,934,831 | 1439 | 31.7335*** | 96.1 | 22.61 | 145.8 | 75.6 | 5.8178* |
| 2003 | 313,091 | 457,992 | 1,745,182 | 5102 | 27.8347*** | 99.7 | 22.38 | 149.7 | 79.3 | 6.9062* |
| 2004 | 321,690 | 489,607 | 1,909,593 | 20,457 | 38.8518*** | 103.4 | 22.48 | 153.5 | 83.6 | 6.9566** |
| 2005 | 351,281 | 547,624 | 2,135,092 | 26,506 | 40.6083*** | 107.1 | 23.30 | 158.6 | 87.7 | 6.5653** |
| 2006 | 344,803 | 501,603 | 1,948,356 | 24,477 | 34.1789*** | 111.0 | 23.27 | 161.3 | 92.4 | 5.5398** |
| 2007 | 327,608 | 454,528 | 1,746,424 | 28,545 | 27.4875*** | 119.4 | 33.40 | 198.6 | 96.7 | 3.9982* |
| 2008 | 349,297 | 508,673 | 1,958,946 | 9436 | 31.1746*** | 121.3 | 35.01 | 202.5 | 98.5 | 3.6587 |
| 2009 | 402,116 | 603,279 | 2,311,095 | 13,925 | 31.0522*** | 125.2 | 39.63 | 221.4 | 98.8 | 4.1720 |
| 2010 | 383,443 | 599,483 | 2,320,154 | 15,532 | 37.6882*** | 128.6 | 45.65 | 249.2 | 95.3 | 6.6685** |
| 2011 | 404,163 | 667,329 | 2,582,837 | 19,039 | 41.6230*** | 131.5 | 48.23 | 260.0 | 93.8 | 7.0164** |

Note: 1. NOT and CPI denote the number of Taiwanese visitors and CPI in the destination countries, respectively.
2. Data about the 14 destination countries was collected during a 14-year period from 1998 to 2011.
3. J–B denotes the basic Jarque–Bera statistics in a standard normal distribution.
4. ***, **, and * indicate significance at the 1%, 5% and 10% significance levels, respectively.

B. Estimation

Using the framework of regression Eq. (3), we may add up the time series to obtain:

$$\sum_{t=1}^{T} n_{it} = \sum_{t=1}^{T} \mu_i + \beta' \sum_{t=1}^{T} \pi_{it}(\gamma) + \sum_{t=1}^{T} \varepsilon_{it}.$$

The equation above is divided by $T$ to obtain the average of each individual country, as stated below:

$$\frac{\sum_{t=1}^{T} n_{it}}{T} = \frac{\sum_{t=1}^{T} \mu_{it}}{T} + \frac{\beta' \sum_{t=1}^{T} \pi_{it}(\gamma)}{T} + \frac{\sum_{t=1}^{T} \varepsilon_{it}}{T}$$

or:

$$\overline{n}_i = \mu_i + \beta \overline{\pi}_i(\gamma) + \overline{\varepsilon}_i. \tag{4}$$

After subtracting regression Eq. (4) from (3), we obtained the following equation:

$$(n_{it} - \overline{n}_i) = \beta' (\pi_{it}(\gamma) - \overline{\pi}_i(\gamma)) + (\varepsilon_{it} - \overline{\varepsilon}_i). \tag{5}$$

Finally, regression Eq. (5) was re-written as:

$$n^*_{it} = \beta' \pi^*_{iy}(\gamma) + \varepsilon^*_{iy} \tag{6}$$

where $n^*_{it} = n_{it} - \overline{n}_i$, $\pi^*_{it}(\gamma) = \pi_{it}(\gamma) - \overline{\pi}_i(\gamma)$ and $\varepsilon^*_{it} = \varepsilon_{it} - \varepsilon_i$.
Regression Eq. (6) is a de-meaned one that excludes the fixed effects of individual countries (i.e., individual-specific means).
After a time overlay of individual countries (except the first stage) we assume that:

$$n^*_i = \begin{bmatrix} n^*_{i2} \\ \vdots \\ n^*_{iT} \end{bmatrix}, \pi^*_i(\gamma) = \begin{bmatrix} \pi^*_{i2}(\gamma)' \\ \vdots \\ \pi^*_{iT}(\gamma)' \end{bmatrix}, \varepsilon^*_i = \begin{bmatrix} \varepsilon^*_{i2} \\ \vdots \\ \varepsilon^*_{iT} \end{bmatrix}.$$

After another overlay of individual countries, we assume that:

$$N^* = \begin{bmatrix} n^*_1 \\ \vdots \\ n^*_i \\ \vdots \\ n^*_n \end{bmatrix}, \Pi^*(\gamma) = \begin{bmatrix} \pi^*_1(\gamma) \\ \vdots \\ \pi^*_i(\gamma) \\ \vdots \\ \pi^*_n(\gamma) \end{bmatrix}, e^* = \begin{bmatrix} \varepsilon^*_1 \\ \vdots \\ \varepsilon^*_i \\ \vdots \\ \varepsilon^*_n \end{bmatrix}.$$

According to the definition above, Regression Eq. (6) can be re-written as:

$$N^* = \Pi^*(\gamma)\beta + e^*. \tag{7}$$

A chief estimator for the determination of effects, model (7) makes estimates in two stages. OLS was used in the first stage to yield $\hat{\beta}$, or the estimate of $\beta$, given the presumed threshold value $\gamma$:

$$\hat{\beta}(\gamma) = \left(\Pi^*(\gamma)' \Pi^*(\gamma)\right)^{-1} \Pi^*(\gamma) N^*. \tag{8}$$

Now that $\hat{\beta}$ is obtained, we may divide the data of inflation $\pi$ into two segments, depending on whether it is larger or smaller than the previously determined, specific threshold value $\gamma$. Data in the two segments, divided by the $\gamma$ value, was used to generate the estimates of $\beta_1$ and $\beta_2$ by means of OLS. Now that we know $\beta = (\beta_1', \beta_2')'$, we may easily infer the estimated value of residual:

$$\hat{e}^*(\gamma) = N^* - \Pi^*(\gamma)\hat{\beta}(\gamma). \tag{9}$$

We may also calculate the sum of squared errors (SSE):

$$\begin{aligned} SSE_1(\gamma) &= \hat{e}^*(\gamma)' \hat{e}^*(\gamma) \\ &= N^* \left(I - \Pi^*(\gamma)\left(\Pi^*(\gamma)' \Pi^*(\gamma)\right)^{-1} \Pi^*(\gamma)'\right) N^*. \end{aligned} \tag{10}$$

After obtaining the SSE for each specific threshold value $\gamma$, we may enter the second stage to estimate threshold values.
The threshold-value estimation in the second stage is intended to compare, according to the principle of minimal $SSE(\gamma)$, all the presumed specific threshold values against the corresponding SSE calculated using OLS. Finally, a threshold value $\hat{\gamma}$ was determined for this model using the corresponding $\gamma$ based on the smallest SSE:

$$\hat{\gamma} = \min_{\gamma} \; SSE_1(\gamma). \tag{11}$$

Now that the minimal $\hat{\gamma}$ is known, the estimator for coefficient estimate is $\hat{\beta} = \hat{\beta}(\hat{\gamma})$; the residual-vector estimator is $\hat{e}^* = \hat{e}^*(\hat{\gamma})$; the estimator for residual variance is:

$$\hat{\sigma}^2 = \hat{\sigma}^2(\hat{\gamma}) = \frac{1}{n(T-1)} \hat{e}^{*\prime}(\hat{\gamma}) \hat{e}^*(\hat{\gamma}) = \frac{1}{n(T-1)} SSE_1(\hat{\gamma}).$$

C. Statistical testing

Although we assumed a threshold in a destination country's inflation and a nonlinear relation between that inflation and the growth in Taiwanese people visiting that particular country, such assumptions for the model's inter-segment threshold effects are hardly supported statistically. Therefore, it is important that tests be conducted for the threshold effect, and we may propose the hypothesis (H0) that there is no threshold effect under the linear constraints:

$$H_0: \; \beta_1 = \beta_2.$$

The alternative hypothesis of H0 is:

$$H_1: \beta_1 \neq \beta_2.$$

Both segments will have the same coefficients if $H_0$ is substantiated, hence the absence of a threshold effect and the degeneration of that equation into a commonly seen single regression equation. Conversely, a rejected $H_0$ indicates that different segments register different inter-segment threshold effects of the consumer-price fluctuations in destination countries $\pi$ on the growth in Taiwanese tourists arriving in that particular country ($n$), and the gap between $\beta_1$ and $\beta_2$ has varying explanatory power for the two segments.
When $H_0$ is substantiated, the linear regression equation will be:

$$n_{it} = \mu_i + \beta_1' \pi_{it} + \varepsilon_{it}. \tag{12}$$

A regression equation is obtained after a fixed-effect transformation:

$$N^* = \beta_1' \Pi^*(\gamma) + e^*. \tag{13}$$

This regression equation enables us to employ the OLS method to obtain $\tilde{\beta}$, which is the estimate of coefficients under restraints in this panel data model, and then obtain the estimated residual $\tilde{e}^*$ according to regression Eq. (9). We may obtain $SSE_0 = \tilde{e}^{*\prime} \tilde{e}^*$ under the aforementioned restraints.
Hansen (1999) recommended that F-test be employed to test the above-mentioned hypothesis, and sup-Wald statistics be used (as the Wald statistics) to test H0:

$$F = \sup F(\gamma). \tag{14}$$

The testing model is:

$$F(\gamma) = \frac{(SSE_0 - SSE_1(\hat{\gamma}))/1}{SSE_1(\hat{\gamma})/n(T-1)} = \frac{SSE_0 - SSE_1(\hat{\gamma})}{\hat{\sigma}^2}. \tag{15}$$

When H0 is substantiated, some coefficients (e.g., the presumed threshold value $\gamma$) do not exist, leading to the nuisance parameters. When the "Davies" problem arises, as pointed out by Davis (1977, 1987), there will be a non-standard distribution of test statistics F. Consequently, Hansen (1996) suggested that the bootstrap method be employed for an approximation of the asymptotic distribution of F statistics while obtaining the P-value of F statistics, so as to decide if H0 should be rejected on the basis of the yielded F-value. Hansen (1996) said that bootstrapping applied to a typical statistical framework will cause the probability distribution to converge to a correct asymptotic distribution, and subsequently achieve a correct first-order asymptotic distribution. That is, the P-values yielded from bootstrapping will approach an asymptotic distribution that proves valid in testing the test statistics.

$\tilde{\pi}_{it}$ and $\tilde{\beta}$ are first estimated when applying the bootstrap method. H0 assumes that $\tilde{\pi}_{it}$ and $\tilde{\beta}$ are the estimates of $\pi_{it}$ and $\beta$, respectively. The random values generated from $\tilde{\pi}_{it}$ and $\tilde{\beta}$, subject to repeated sampling as per the bootstrap method, are used to explore the statistical distribution of F-values. In other words, it is assumed that $\tilde{\varepsilon}_{it}$ is a random variable selected from $\tilde{\beta}$; $\tilde{y}_{it}$ is yielded from Eq. (12); $\tilde{F}(\gamma)$ is the threshold Wolfowitz Runs test value calculated using $\tilde{y}_{it}$; the distribution of $\tilde{F}(\gamma)$ is the bootstrapping distribution based on Wald test. After repeated sampling using the bootstrap method, the P-value becomes:

$$P = P\left(\tilde{F}(\gamma) > F(\gamma)|\zeta\right) \tag{16}$$

where $\zeta$ is the conditional expected value of $\tilde{F}(\gamma) > F(\gamma)$ in observed data. Therefore, the P-value yielded from repeated sampling using bootstrap method is the $\tilde{F}(\gamma)$ calculated by simulating a lot of independent Wald-tests. Such a P-value rejects H0 because it is smaller than the critical value.

D. Asymptotic distribution in threshold model

Both Chan (1993) and Hansen (2000) noted that, in case of a threshold effect ($\beta_1 \neq \beta_2$) in the regression equation, there will be super-consistency regarding the least squares estimators of threshold. Chan (1993) consequently inferred an asymptotic distribution, which however is affected by the nuisance parameter and leads to a highly non-standard distribution, hence the unsuitability for statistical inferences. To solve that problem, Hansen (1999, 2000) in a simulation of "likelihood ratio test" obtained the asymptotic distribution of statistics to test the model's threshold effect.

While trying to infer the model of panel threshold effect, Hansen (1999) proposed the use of a likelihood-ratio test to explore the distribution of test statistics, hoping to correct the non-standard distribution resulted from the nuisance parameter in asymptotic distribution. The null and alternative hypotheses he proposed are:

$$H_0 : \gamma = \gamma_0$$
$$H_1 : \gamma \neq \gamma_0$$

where $\gamma_0$ is the true value of threshold values $\gamma$.

The testing model is:

$$LR_1(\gamma) = \frac{SSE_1(\gamma) - SSE_1(\hat{\gamma})}{\hat{\sigma}^2} \tag{17}$$

when the value of $LR_1(\gamma_0)$ is so large that the P-value falls outside the confidence interval, Hansen (1999) said it is acceptable to reject H0 that equates the estimated threshold values $\gamma$ to the true value $\gamma_0$.[5] Hansen (1999) proved that when H0 is substantiated ($H_0 : \gamma = \gamma_0$) and certain appropriate hypotheses are met[6]:

$$LR_1(\gamma) = d\zeta \tag{18}$$

where $\zeta$ is a random variable of distribution function (when $n \to \infty$):

$$P(\zeta \le x) = \left(1 - \exp\left(-x/_2\right)\right)^2. \tag{19}$$

The incremental P-value can be obtained using the likelihood-ratio method. As Hansen (1999) proved that the asymptotic distribution is pivotal, we may rewrite the distribution of function (19) as:

$$c(\alpha) = -2\log\left(1 - \sqrt{1-\alpha}\right). \tag{20}$$

From Eq. (20) we can easily derive the critical value. When $LR_1(\gamma)$ exceeds $c(\alpha)$ at a confidence level below $\alpha$, we can reject H0 that equates the estimated threshold values $\gamma$ to the true threshold values $\gamma_0$.

## 4. Empirical findings

This study uses the panel threshold effect to discuss how a destination country's CPI affects the number of Taiwanese people visiting that particular country. It assumes one or more threshold values in a destination country's consumer prices, which is related to the number of Taiwanese people visiting that particular country in a nonlinear manner, with asymmetric upper and lower boundaries.

Given the assumed presence of double and single threshold effects, an empirical study was conducted using the nonlinear single regression Eq. (2): $n_{it} = \mu_i + \beta_1' \pi_{it} I(\pi_{it} \le \gamma_1) + \beta_2' \pi_{it} I(\gamma_1 < \pi_{it} \le \gamma_2) + \beta_3' \pi_{it} I(\pi_{it} > \gamma_2) + \varepsilon_{it}$, which was re-written from regression Eq. (1) in the threshold model. [7]There is a nonlinear relation between consumer prices, a threshold variable in this case, and the number of Taiwanese people traveling abroad.

As for the empirical findings, it is observed from Table 3 and Fig. 1 that the CPI threshold values ($\gamma_1$ and $\gamma_2$) obtained from the test for double threshold effects were 102.5 and 137.90, respectively. And yet, the F statistics and P-values tested indicated an extremely insignificant relation between the two threshold values assumed (P-value = 1.000), indicating the much likely 100% rejection of the hypothesis that there are no two threshold values. Given the absence of two threshold values, a test was conducted for the single threshold effects and suggested a 137.90 single threshold value ($\gamma_2$) of CPI, which nevertheless remains insignificant (P-value = 0.28).

The tests for threshold effect invariably generated insignificant results. According to empirical findings, however, such insignificance appears mitigated when the single threshold value is 137.90. This present study went on to analyze the symmetry between data in two segments (i.e., the data above and below the single threshold value of 137.90). The first segment in Table 4 indicates that, when the threshold variable CPI ($\pi_{it}$) is smaller than the threshold values ($\gamma_2$) (i.e., $\pi_{it} < 137.90$), the *t*-statistics of $\beta_1$ coefficients are 4.79 and 3.23, respectively, considering the homogeneous and heterogeneous standard deviations in this segment. That means the $\beta_1$ values are always significantly and positively related at the 1% significance

[5] It is worth noting that Eqs. (17) and (15) are used to test different hypotheses. The distribution of $LR_1(\gamma_0)$ is meant to test H0, which equates the estimated threshold values $\gamma$ to the true threshold value $\gamma_0$ ($H_0 : \gamma = \gamma_0$); while the F-distribution is intended to test if both segments have the same coefficients and the absence of a threshold effect ($H_0 : \beta_1 = \beta_2$).

[6] Some appropriate hypotheses are listed as hypotheses 1 to 8 in the appendix (p. 363) of the study of Hansen (1999).

[7] This formula is purely a hypothesis of double threshold effect.

**Table 3**
Testing for the threshold effect of destination countries' CPI on the number of Taiwanese people traveling abroad.

| Test for single threshold effects | | | Test for double threshold effects | | | |
|---|---|---|---|---|---|---|
| Threshold values | F | P-value | Double threshold values | | F | P-value |
| 137.90 | 18.22 | 0.28 | 102.50 | 137.90 | 2.28 | 1.00 |

Note: 1. The P-value and F-statistics generated from bootstrapping were the results of repeating the sampling process for 300 times.
2. When the single and double threshold effects were tested at the 10% , 5% , and 1% levels, the critical values of F-statistics were 25.90, 29.82, 41.46 and 16.50, 18.37, 23.66, respectively.

level. Likewise, the second segment indicates that, when the threshold variable CPI exceeds the threshold values (i.e., $\pi_{it} > 137.90$), the $t$-statistics of $\beta_2$ coefficients are 4.32 and 3.37, respectively, considering the homogeneous and heterogeneous standard deviations. The $\beta_2$ coefficients proved significantly and positively correlated at a 1% significance level. Since both segments have positively and significantly correlated coefficients (i.e., regression coefficients $\beta_1$ and $\beta_2$), a destination country's CPI affects the number of Taiwanese people visiting that particular country in a significant and positive manner. In other words, the rising prices in a destination country will encourage Taiwanese people to visit that country. That finding showed something against the law of demand: instead of undermining the demand for traveling overseas, a rise in consumer prices probably reflects an improving economy and a higher quality of life in a destination country, which fuels efforts to refine products and perfect tourism facilities. Since a fine-quality tourism environment with high consumer prices has the potential of luring quality-seeking tourists, surging consumer prices may push up the tourist arrival figures and result in a positive relation between each destination country's consumer prices and tourist arrival number. According to the threshold test results in this present study, there is a linear and positive relation between the destination countries' CPI and the number of Taiwanese people traveling abroad, instead of the assumed nonlinear threshold effects with asymmetric upper and lower boundaries.

## 5. Conclusions

This study explores the potential *threshold effect* of consumer prices in destination countries on the number of Taiwanese people traveling abroad, so as to examine how the increasing prices in a destination country affect the number of Taiwanese people visiting that particular country. It assumes one or more threshold values in the destination countries' consumer-price inflation, and also a

**Table 4**
Estimated threshold parameters.

| | | | |
|---|---|---|---|
| Threshold estimate | | 137.90 | |
| Confidence region | | 120.00 | 137.90 |
| | Coefficients | OLS se | White se |
| $\hat{\beta}_1$ | 3563.75 | 744.37 | 1102.71 |
| $\hat{\beta}_2$ | 1785.84 | 413.84 | 529.37 |

Note: The parameters $\beta_1$ and $\beta_2$ are the regression coefficients below and above the threshold values, respectively.

nonlinear relation between such prices and the number of Taiwanese visitors in that particular country, with asymmetric upper and lower boundaries. Totally 14 tourist destination countries were sampled during a 14-year period from 1998 and 2011 to obtain balanced panel data, which comprises 196 observations for the two variables (i.e., the destination countries' CPI and the number of Taiwanese people traveling abroad) for a discussion of panel threshold effect.

In the tests for panel threshold effects, we invariably derived from empirical finding an insignificant threshold effect with regard to the assumed presence of double and single threshold effects, which indicates a linear relation between the destination countries' CPI and the number of Taiwanese people traveling abroad. According to an ensuing inter-segment symmetry analysis, impact factors within the range of study invariably indicate significantly positive relations, a sign that a destination country's CPI has a noticeably positive influence on the number of Taiwanese people visiting that particular country. That is, the rising prices in a destination country will encourage Taiwanese people to visit that country. Findings from this study showed that, instead of undermining the demand for traveling overseas, a rise in consumer prices probably reflects an improving economy and a higher quality of life in a destination country, which further fuels efforts to refine products and perfect tourism facilities. Since a fine-quality tourism environment with high consumer prices has the potential of luring quality-seeking tourists, surging consumer prices may push up the tourist arrival figures and result in a positive relation between each destination country's consumer prices and tourist arrival number. According to the threshold test results in this present study, there is a linear and positive relation between the destination countries' CPI and the number of Taiwanese people traveling abroad, instead of the assumed nonlinear threshold effects with asymmetric upper and lower boundaries.

The threshold analysis in this study sheds light on the future of Taiwan's tourism industry: Instead of putting all the blame on a high CPI, the major factors behind lackluster tourist arrivals in Taiwan are how well established the overall tourism environment is, how

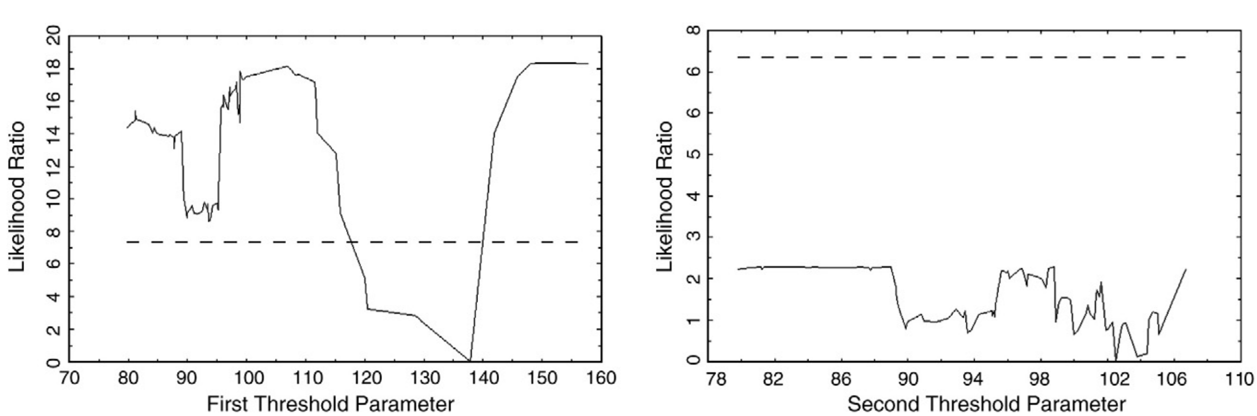


**Fig. 1.** Testing for the double threshold effect.

accessible the traffic infrastructure is, and how much the quality of tourism services has improved. France, the Switzerland and Asian regions such as Japan, Hong Kong and Singapore are perfect examples of how a country with high consumer prices effortlessly achieves growth in tourist number with reputation among tourists worldwide. The Taiwan government has in recent years been straining toward the goal of "100% increase in tourist arrivals". And yet, the SARS outbreak dealt a severe blow to the country's tourism market and left it with a meager 2.25 million annual tourist arrivals in 2003. According to the forecast of World Travel & Tourism Council (WTTC), the global demand for tourism and travel totalled US$ 5,490,400 in 2004, or 3.8% of global GDP, with worldwide tourism investments expected to reach US$ 8,023,000,000 (or 9.4% of total investments) before increasing by 100% in 2015. Tourism will be an integral part of national development worldwide, and Taiwanese tourism policies need to move in the correct direction under a clear guidance that maximizes the utility of national investments in the sector. Currently Taiwan is ranked at the bottom of tourism-developing countries in Asia and beyond, and the Tourism Bureau has for many years been examining the reasons why foreign tourists are less interested in Taiwan and why the local tourism industry fails to deliver results as expected. It seems that Taiwan's tourism authorities often attribute the sluggish growth, if any, of tourist arrival numbers to the exorbitant consumer prices, including hotel accommodations and dining costs, which according to conclusions of this present study is a near-sighted and biased argument. Take a look at Japan, South Korea, Hong Kong, Malaysia, Singapore, and the other neighboring countries/regions, and the Taiwanese will be ashamed for their poor traffic infrastructure and complementary facilities. Compared to those countries' convenient external traffic links to international airports, how is Taiwan expected to lure a lot of foreign tourists on a sustainable basis? Moreover, countries with the world's largest trade surplus in tourism (e.g., France, Italy, Spain, and the U.S.) all have a higher CPI than Taiwan. Statistics indicated that France attracted 80–90 million tourists throughout 2007 at a time when Paris had the second highest consumer prices in the world. Dubai and the other tourist destinations emerging in recent years exemplified the same fact and proved the correctness of conclusions yielded in this study: the only way for Taiwanese tourism industry to survive is to offer sophisticated services, with attention paid to every detail of a complete package of traffic facilities, infrastructure and tourist facilities. That way, the Taiwan government will be able to achieve the long-awaited growth in tourist numbers. The lifting of ban on Chinese tourists in Taiwan a few years ago resulted in a considerable number of Chinese people visiting the island country, which nevertheless could be a false sign of growth given the fact that tourists from non-China regions remain unchanged in number. All in all, we sincerely hopes the Tourism Bureau will see its years-long effort bear fruits soon with tourist arrivals reaching 5 million in a 100% growth.

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